Application Guidelines

EV3 Inverter Drive for ZPV* & YPV* Variable Speed Compressors

EV3150B & EV3185B

EMERSON

About these guidelines

The purpose of these guidelines is to provide guidance in the application of Emerson drives in users' systems. They are intended to answer the questions raised while designing, assembling and operating a system with these products.

Besides the support they provide, the instructions listed herein are also critical for the proper and safe functioning of the drive. The performance and reliability of the product may be impacted if it is not used according to these guidelines or is misused.

These application guidelines cover stationary applications only. For mobile applications, please contact the Application Engineering department at Emerson as other considerations may apply.

1   Safety instructions

The Emerson EV3 drives are intended for installation in systems in accordance with EN 60335-1. They may be put to service only if they have been installed in these systems according to instructions and conform to the corresponding provisions of legislation. For relevant standards please refer to the Manufacturer's Declaration, available on request.

Copeland™ scroll compressors are manufactured according to the latest European and US safety standards. Particular emphasis has been placed on the user's safety.

These instructions should be retained throughout the lifetime of the compressor and the drive.

You are strongly advised to follow these safety instructions.

1.1   Icon explanation

Explanation of used symbols	
⚡	Electric shock hazard. May cause severe injury or death!
⚠	General warning about a possibility of non-electrical damage or injury. Take necessary protections to avoid injury!
🔥	General warning about risk of burning on hot surfaces. Take necessary precautions to avoid injury!
EX	General warning about explosive atmosphere. Take necessary precautions to avoid explosion and injury!

Table 1: Explanation of used symbols

1.2   Safety statements

The EV3 drive is designed to be used in HVAC/R systems and can only be installed, operated or maintained by qualified electrical personnel with additional system-related expertise. Please immediately contact the manufacturer for support if the user is uncertain with any safety-related issue.

The drive operates at hazardous voltages which can cause severe personal injury or equipment damage. Extreme care and precautions must be taken when handling the product.

1.3   General instructions

	Safety risks (read carefully!)
⚡	After disconnecting power, wait 10 minutes before removing the drive enclosure. Before operating and maintenance work always check that all voltages at the terminals are zero or at levels which are harmless.
⚡	Always make sure the compressor has stopped completely before removing the drive enclosure. As soon as the drive is connected to the power supply the input terminals will be at line voltage even when the compressor is not rotating.
⚡	Do not measure insulation resistance or dielectric rigidity directly via the input terminals with power supply connected.
⚡	Review relevant safety standards concerning installation of high voltage devices, as well as the regulations for the correct use of personal protective equipment.
⚡	The drive can only be used for purposes specified by the manufacturer.
⚡	This product can cause both AC and DC earth leakage current. To protect against both kinds of leakage current an AC/DC sensitive RCD must be installed in front of the EV3 drive.
⚡	Do not make any modifications or replace any components as these actions may lead to consequences including but not limited to fire and electric shock and will void the warranty. Product modifications are not allowed. The manufacturer is not responsible for any unauthorized modification made to the product by the user.
⚡	A proper earth connection of the drive must be ensured to avoid the risk of electric shock.
⚡	The IP20 protection is only given after all terminals are connected with isolated ring and isolated blade terminals!
⚡	In special cases of using the drive without the IP20 enclosure, which is in general forbidden, the protection against direct and indirect touching must be part of the system design to avoid any risk of electric shock!
⚡	DC/AC chokes must be covered on system side to avoid any risk of electric shock!
⚠	Use safety shoes to avoid foot injury. Handle the drive carefully.
⚠	Protect the drive from dust. During installation make sure to clean off the debris caused by drilling. Remove any conductive debris inside the drive which can cause damage or malfunction.
♨	Before touching the heatsink or unpowered chokes, make sure that the temperatures are within safe limits to avoid burn injury.
EX	In general, the drive cannot be used in an environment where a direct contact with flammable or explosive substances can occur. Furthermore, use in a transcritical system is not allowed. Use with A2L flammable refrigerants is only foreseen in systems based on the IEC 60335-2-40:2018-05 standard with some restrictions shown in these guidelines.

Table 2: Safety risks

1.4   Use with A2L refrigerants

EX	The EV3 drive is not designed or qualified based on the ATEX directive! Use with A2L flammable refrigerants is possible if the system design is based on the IEC 60335-2-40:2018-05 standard.

The EV3 drive has been assessed in accordance with IEC 60335-2-40, and does not represent a source of ignition for A2L if the following points are respected:

▪ The drive mounting area must be in **Zone 2** or outside any ATEX zone and in line with "**Pollution Degree 2**" classification.

▪ No airstream guided over the drive itself.

- Ensure that the airstream over the heatsink does not influence the environment of the drive (keep pollution degree 2).
- No condensation under normal operation.
- The IP class of the drive mounting area must be in line with the system standard.

2 Product description

2.1 General information about the EV3 drive

The EV3 inverter drive has been developed specifically for Copeland scroll compressor models ZPV066/096 and YPV066/096. These are variable speed compressors with permanent magnet synchronous motors. The drive will power the compressor, control the compressor running speed, provide compressor and drive protection and communicate with the master controller. The drive has integrated fans for cooling and is typically installed in a system near the compressor.

2.2 Drive highlights

The EV3 drive at a glance:

- Control of Copeland variable speed ZPV*/YPV* compressors in commercial environments
- Predefined selection for compressor
- Active envelope protection
- Special envelope related overload protection
- Compressor crankcase heater functionality
- Operation ambient temperatures -25 to 60 °C
- Controllable via RS485 and Modbus® RTU
- Automatic baud rate detection (19.200 bps)
- Designed and qualified based on EN 60335-1 for the European market
- UL 60730-1 approval for the North American market
- Safety Input to wire a high-pressure limiter
- Discharge line temperature sensor input (DLT)
- Integrated passive power factor correction
- Integrated EMI filter
- Inrush-current limitation
- Rated currents @ 50 °C
- Enclosure with integrated heatsink and fan for cooling
- Speed-Drop Protection mode for increased system stability

2.3 Models

Drive model	Power supply 50/60 Hz	Max. input current @ 50 °C	Max. output current @ 50 °C	Max. input power @ 380 V
EV3150B	3~ 380 to 460 VAC	27 A	27 A	15 kW
EV3185B	3~ 380 to 460 VAC	38 A	38 A	18.5 kW

Table 3: Voltage, current and power range

NOTE: **The power range in Table 3 is to be considered as an indication depending on the system design and compressor motor. The rated voltage to run ZPV*/YPV* compressors in the full dedicated envelope and to pass EN 60335-2-34 tests is 400 VAC for three-phase drives.**

2.4 Advanced technical information

Storage temperature	-40 to +85 °C
Max. operating temperature	-25 to +65 °C
Max. full performance operating temperature	-20 to +50 °C
Humidity	0 to 95 % rH non-condensing
Altitude	Max. 2000 m above sea level
Pollution degree	2
Drive enclosure protection	IP20
DC choke protection	IP00
Communication	RS485 Modbus (RTU) Baud rate 19.200 bps Slave ID: 45
Sensor input	Discharge line temperature DLT / NTC 10 kΩ
Safety torque off input	Designed to connect a safety high-pressure limiter
Max. efficiency	~98 %
Max. power factor	~0.94 w/ integrated PPFC

Table 4: Advanced technical information

2.5 Conformity to directives and standards

The EV3 drive has been designed and developed especially for the European commercial market based on applicable European Directives. The design is qualified by main safety standards EN 60335-1 (Safety for household and similar electrical appliances, Part 1: General requirements), EN 60335-2-34 (Part 2-34: Particular requirements for motor-compressor) and EN 60730-1 (Automatic electrical controls for household and similar use).

The EV3 drive complies with EMC standard EN 61800-3 Category C3. Depending on the unit design, the drive may comply with Category C2 as well. However, if C2 cannot be achieved with the drive alone, an external filter may be used. Recommended ferrites are shown in paragraph 3.4 "**Electrical installation**".

Furthermore, the EV3 drive models comply with standard EN 61000-3-12 for harmonic currents higher than 16 A. Further system-related requirements for compliance with the above-mentioned standards are detailed in Chapter 3 "**Installation**".

2.6 Nomenclature

Table 5 hereunder explains the nomenclature based on the drive model EV3185B-K1-XXX.

EV	3	185	B	-	K	1	-	XXX
Definition								
EV	Product family (Electronics Variable speed)							
3	Third generation							
185	Input power Format: XX.X (kW) eg, 18.5 (kW)							
B	Communication: RS485 5V Modbus RTU							
-								
K	3-Phase, 380-460 VAC							
1	Power output codes: 1-9							
X	Type of module: 1-4: OEM 5-6: Export 8-9: Aftermarket							
XX	Software/hardware variations							

Table 5: Nomenclature

2.7 Identification

The rating plate on the drive gives information about the drive, including model, serial number, rated input and output, and certificate approval.

Model:EV3185B-K9-294

S/N:AD16L2103

Input:3PH 380-460VAC 50/60Hz Max 38A
Component Made In China

EMERSON

E253322
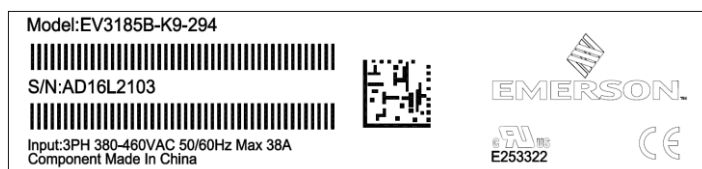
Figure 1: Rating plate

It is advised to check and confirm the rating plate before installing or operating the equipment.

3.1   Handling

- Correct handling and storage of the drive is essential in preventing mechanical damage.
- The box and the protection bag inside the box have to be opened with care. Do not use any sharp object to open the protection bag or cut across the drive.
- Once opened do not stack the drives.
- Do not use chemicals or solvents to clean the drive.
- Do not drop any mechanical tools on the drive.
- Check that the cooling slots, fans and heatsink are free of dust to ensure efficient cooling.

3.2   Terminals and LED's

Table 6 and additional illustrations explain the function and location of the drive terminals and LED's.

Terminal/LED	Function
A	**Power input terminals:** 3-Phase: L1 / L2 / L3 ⏚E
B	**Compressor terminals**: U / V / W
C	**Control terminal:** 1: DLT / Discharge line temp. sensor NTC 10k 2: 5 V / 5 VDC powering the DLT sensor 3: STO / Safety torque Off (high-pressure limiter) 4: 24 V / 24 VDC STO (powering the high-pressure limiter) 5: B / Modbus data channel B (physical RS485) 6: A / Modbus data channel A (physical RS485) 7: GND / Modbus ground (physical RS485) 8: 5 V / 5 VDC optional for the RS485 communication 9: 24 V / N/A
D	Service port for updating software with a special tool
E	Power LED (green)
F	Fault LED (red)

Table 6: Terminals and LED's
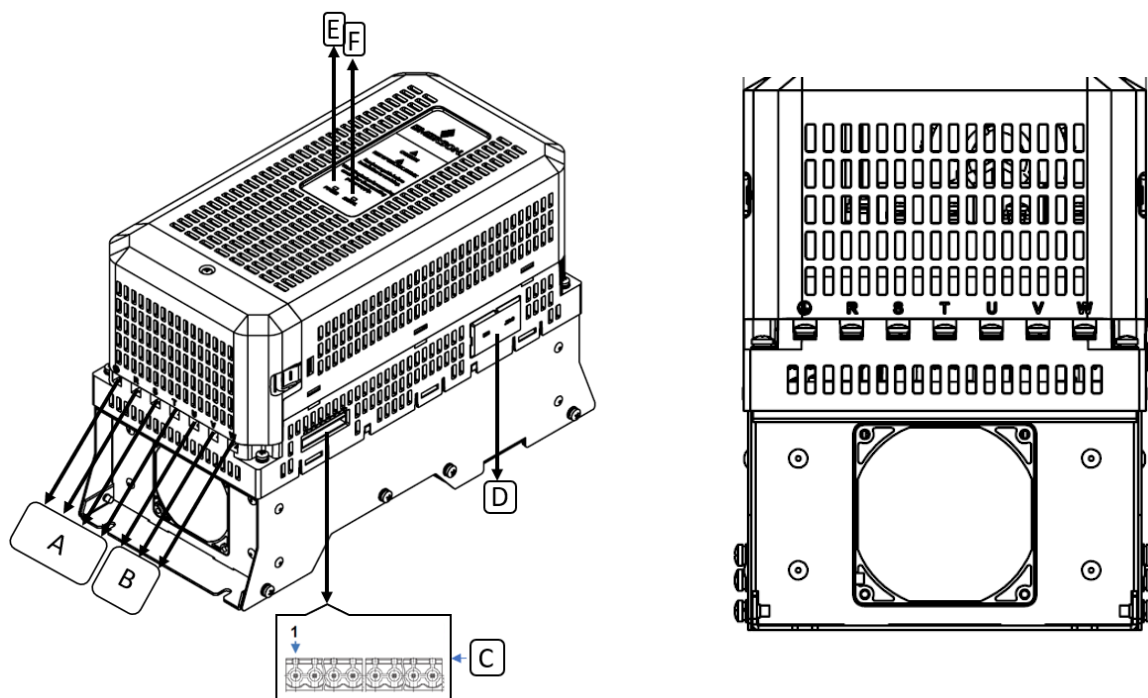
Figure 2: EV3150B, EV3185B, side and front views

3.3 Mounting

The drive should be located as close to the compressor as possible, preferably within 1 metre of the compressor. To avoid electromagnetic interference please ensure that the motor cables do not cross or attach to any other connecting cables.

There should be at least a natural air stream inside the cabinet and around the drive to keep the temperature below 60 °C.

There are holes in the drive mounting flange for mounting purposes. These holes will accommodate M6 sized screws.

The panel on which the EV3 drive is mounted must be able to support its weight, ie, 17 kg.

The drive should be positioned in such a way that the input and output terminals are on the bottom side. After connecting the input and output cables, one must not forget to place back the protection cover for the terminals.

<u>Caution:</u> **Respect the maximum screw torques to avoid any damage to the frame:**

- **M5 screws: 3.9 Nm**
- **M6 screws: 6.7 Nm**

To achieve better cooling it is recommended to mount the drive in the lower or middle part of the cabinet. Ensure that the drive is mounted in such a way that good natural convection is possible. **Figure 3** and **Table 7** below show the minimum clearance spaces to other components and devices near the drive. In addition to those requirements, a decent height between the case and other components and devices is needed.
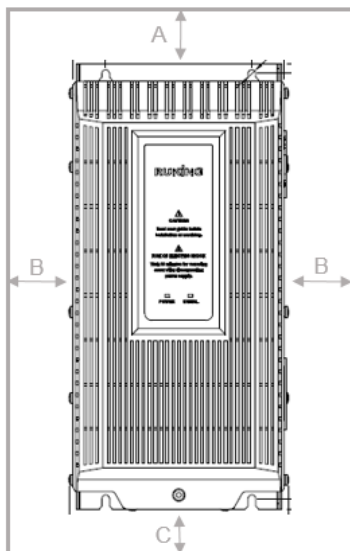
Figure 3: Minimum mounting clearances

Recommended minimum clearance space on the top, bottom, left and right sides		
A (mm)	B (mm)	C (mm)
100	30	100

Table 7: Clearance to other components and devices

NOTE: **The clearance spaces provided in Table 7 should be used only for space to other components/devices and not as a reference for the cabinet dimensions in which the EV3 drive will be placed.**

NOTE: **For more information about drive dimensions and mounting please refer to Appendix 1.**

3.4 Electrical installation

⚡	Please read carefully the safety instructions in **Chapter 1** and **Table 1**!

3.4.1 Earth leakage protection

In all inverter devices like the EV3 drive, earth leakage current (DC, AC) may occur. To protect against both kinds of leakage currents, an AC/DC-sensitive residual current circuit breaker must be installed in front of the EV3 drive.

3.4.2 Grid supply and compressor wiring

Figure 4 shows the general wiring to the power grid and to the compressor. This wiring diagram does not show any system-related components like fuse breaker, RCD and the additional ferrites for EMC.

Paragraph 3.4.6 "**Control terminal**" shows how to wire control-related components like DLT-sensor, high-pressure limiter and the RS485 serial communication (Modbus) to the drive.
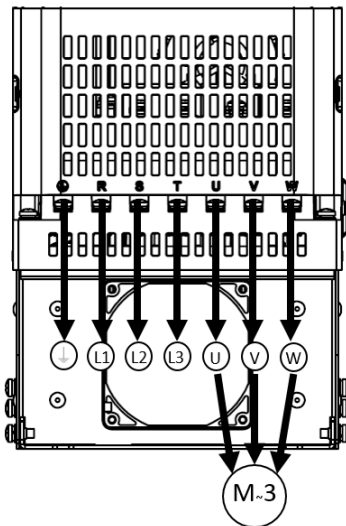
Figure 4: Wiring EV3150B, EV3185B

3.4.3 DC chokes

The integrated DC choke has protection class IP00 and temperature class H. The choke is positioned between the heatsink of the drive and the drilled metal sheet, within the lower metal case. The fan provides the necessary airstream for proper cooling. The chokes are fully covered to protect against direct touching. Short connecting cables are used to minimize the possibility of EMI issues. The choke dimensions are shown in **Appendix 2: "Choke dimensions"**.

Drive model	Choke model	Number of chokes	Electrical parameters
EV3150B	R4002RJ	1 x DC	2 mH ± 10 %, 40 A
EV3185B	LE105-5002	1 x DC	2 mH ± 10 %, 50 A
Safety protection: IP00, Class 0 / Temperature class: H			

Table 8: DC chokes

3.4.4 Power grid connection

Table 9 includes information on how to connect the drive to the grid. The maximum input current is based on a power factor of approximately 0.9. The ferrites, fuses and cable cross sections should be considered as a recommendation and can be different based on the system design. One ferrite is needed for the input cable (L1, L2, L3). The PE cable must not be passed through the ferrite. The connection between the cables and the drive screw terminals should be done with 5 mm ring terminals. The drives are IP20 protection class; therefore, make sure to re-screw the terminal protection after wiring the drive in order to maintain the standard. Also, the use of isolated ring and isolated blade terminals is mandatory for all terminals to maintain the IP20 class.

Power grid	3-Phase grid: 400 VAC 50/60 Hz (L1, L2, L3, PE)			
Drive model / choke	Max input current (A)	Fuse or circuit breaker (A) @ 30 °C	Cable cross section (mm²)[1] @ 60 °C ambient	Usable Ferrite(s) to reduce EMC noise
EV3150B 1 x DC choke	27	32 Type B	6	1 x H63x38-25 KH10 (3 turns)
EV3185B 1 x DC choke	38	50 Type B	10	1 x H63x38-25 KH10 (3 turns)

[1] *Based on: DIN VDE 0298-4 (conductor temperature 90 °C, laying method E)*

Table 9: Connection to the input power grid

The grid must provide a $R_{SCE} \geq 250\ \Omega$, together with a system input current greater than 16 A on each phase to be in line with standard EN 61000-3-12.

For users who are unable to qualify for EN 61800-3 Category C2, an external EMI filter can be fitted in front of the drive.

3.4.5 Compressor connection

Table 10 shows information on how to connect the drive to the compressor. The connecting cables are rated at 90 °C. The cable cross-section is rated for a maximum ambient temperature of 60 °C.

Drive model	Max output current (A)	Cable cross-section (mm²)[1] @ 60 °C ambient	Usable ferrite(s) to reduce EMC noise
EV3150B	27	6	1 x H63x38-25 KH10 (3 turns)
EV3185B	38	10	1 x H63x38-25 KH10 (3 turns)

[1] *Based on: DIN VDE 0298-4 (conductor temperature 90 °C, laying method E)*

Table 10: Compressor connection

The drive output terminals are named U, V, W. In addition to this, there is a PE terminal which must be wired directly to the compressor earth point. The cables should be as short and the ferrites as close to the drive as possible. In any case the motor cables should not cross any other cables to avoid EMI issues. By using a shielded cable, which is in general not designed for cable lengths less than 2 metres, ensure proper shielding on both sides to get best results. One ferrite is needed for the output cable (U,V,W). The use of isolated ring and isolated blade terminals is mandatory for all terminals to maintain the IP20 class.

3.4.6 Control terminal

Each drive has a 9-pin control terminal including the 9-pin plug counterpart (JITE PTB750B-00-1-09-3). The 5 V terminals are designed to provide voltage supply to the DLT input, the STO input, ie, high-pressure limiter (see paragraph 3.4.8 "**STO input**"), and if necessary to the RS485 serial communication circuit. No other usage of these 5 V and 24 V power supplies is allowed.
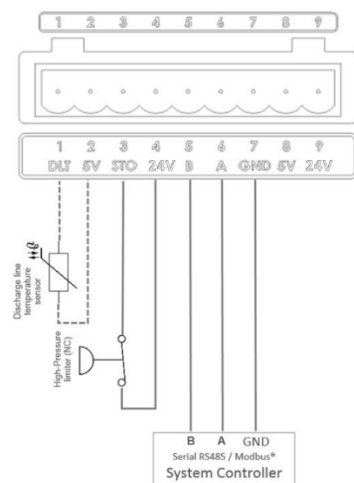
Caution: Consider the total maximum output currents:
- **Terminal 5 V (2, 8) < 150 mA**

Figure 5: Control terminal

3.4.7 DLT input

To protect the compressor against high discharge temperatures it is possible to connect a discharge line temperature sensor (DLT) between control terminals 1 and 2. This sensor input is configurable via register [207]. By default, it is disabled.

Sensor specifications:
- Type: NTC 10 kΩ @ 25 °C
- Accuracy: ± 1 %
- Powered by: Internal 5 VDC (terminal 2)
- Temp. range: -40 to +150 °C
- Reference: Emerson TP1 series

The sensor should be mounted on the discharge line approx. 120 mm away from the compressor outlet.

After starting the compressor, the drive observes the temperature from the DLT sensor. The observable temperature range is between -40 and 150 °C.

3.4.8 STO input

An STO input (**S**afety **T**orque **O**ff) is available between terminals 3 and 4 to connect a safety high-pressure limiter. The input is designed as a protected electronic circuit (PEC) based on the safety standard EN 60335-1. In case of a high-pressure situation the drive will let the compressor stop immediately. The drive will remain in a safe state until the controller sends a clear fault command to the drive.

NOTE: **It is not allowed to use any other external power supply with a higher voltage rating to avoid damaging the STO input!**

High-pressure limiter specifications:
- Type: Safety switch (NC, ie, normally closed; based on latest version of EN 12263)
- Contacts: Golden plated contacts
- Powered by: Internal 24 VDC (terminal 4)
- Current flow: Typically ~10 mA
- Reference: Emerson PS4 series

<u>**Caution:**</u> **Connect the safety limiter directly to terminals 6 and 7 without any relay etc. in between. Otherwise the safety will probably not be safeguarded any longer.**

3.4.9 Modbus communication

The drive acts as a Modbus slave with a pre-selected address 45. The serial communication between drive and any kind of controller or user interface is physically driven via RS485 (control terminals 5, 6 and 7) and logically via the Modbus RTU protocol. If a master controller needs to be supplied with 5 VDC the control terminal 8 can be used.

During start-up cycle, if the auto-adaptive function is enabled, the drive can automatically detect the baud rate and parity. If communication auto-adaptive function is not enabled, the drive will use baud rate and parity read from EEPROM. Further information is provided in the Modbus map.

3.4.10 Drive cooling control

The drive provides temperature values from the power modules mounted on the heatsink. These values should be used to monitor and control proper drive cooling from system side.

Dedicated registers for temperature sensing:
- [70]: PIM Temperature
- [22]: PIM Overtemperature
- [42]: PIM Speed-drop protection limit

Exceeding the overtemperature limit (register [22]) the drive will immediately shut down the compressor. When the temperature of the power module reaches 80 °C (stored in register [42]), the fan starts close to full-speed and then gradually reduces its speed, while the temperature of the module decreases. The fan will stop only if the drive is turned off.

4 Start-up & operation

The configuration and control of the drive are based on the #OneEmerson Modbus® Map.

4.1 #OneEmerson Modbus® Map

The #OneEmerson Modbus Map is provided as a separate document which shows also the status, alarm, configuration and control registers. Furthermore, it provides an advanced register description.

For the latest version of the Modbus map, please contact the Application Engineering department at Emerson.

4.2 Drive configuration

The EV3 drives were specially designed for the ZPV066/096 and YPV066/096 compressors. The compressor code will be set by default, so it will not have to be introduced by the user. The standard default configuration may be used, or it may be adapted to the user's requirements.

Before starting the configuration, the user has to introduce the password 9029 (decimal value) in register [200], in order to have access to registers [201] to [234]. **Table 11** describes the first steps in configuring the drive.

Step	Action
1	DLT sensor used? ■ **Yes:** Connect the sensor to pins 1 and 2 of the communication terminal. By default, the DLT is enabled. ■ **No:** Introduce the value 0 in register [207] or connect a resistor between pins 1 and 2.
2	STO sensor used? ■ **Yes:** Connect the sensor to pins 3 & 4 of the communication terminal. ■ **No:** Place a jumper between pins 3 & 4 of the communication terminal.

Table 11: Configuration steps

NOTE: **The drive stores the configuration from registers [200]-[213] after each power cycle. Wrong configuration will not be cleared with a power cycle!**

4.3 Drive operation modes

There are two main operation modes:
- Compressor Run mode
- Stator Heating mode

While selecting both control modes at the same time the compressor run mode has the highest priority. While stator heating is already on, sending a compressor run command will terminate the stator heating mode and start the compressor.

4.3.1 Compressor Run mode

Go through the following sequence:
- make sure that there are no faults;
- turn the compressor on by selecting Enable in the list, register [100];
- introduce the speed demand in register [101].

The drive will accelerate and decelerate by the rates defined in [211] and [212].

4.3.2 Stator Heating mode

Go through the following sequence:
- if the compressor is running, set the value of the speed demand in register [101] to 0;
- make sure the compressor is enabled (select Enable in the list, register [100]);
- introduce the percentage of power needed in register [102], based on the algorithm below. Note that once a value is introduced in register [102], stator heating mode is automatically enabled. There is no separate register for turning on and off the stator heating mode.

The power demand must be written in register [102]. The value represents the percentage of power (0 - 100 %). The maximum power that can be commanded on the stator is readable via register [52]. The relation between the power and the value introduced in register [102] is the following:

- If the value is a multiple of 10:

$$Power \sim 150 \times (\frac{[102]}{100})$$

- If the value is not a multiple of 10:

$$Power \sim 150 \times \frac{([102] \; div \; 10 + 1) \times 10}{100}$$

(Stator Heating Demand = value stored in register [102])

The power commanded on the stator is interpreted by the drive according to **Table 12**:

User demand	Drive received
1 – 10 %	10 %
11 – 20 %	20 %
21 – 30 %	30 %
31 – 40 %	40 %
…	…
81 – 90 %	90 %
91 – 100 %	100 %

Table 12: User commanded power

4.4 Envelope control

The drive offers 4 different envelope control modes allowing the compressor to operate at four different safety levels within the dedicated envelopes. Two conceptually different methods are provided to achieve this:

- **Passive Envelope Control (modes 0, 1, 2)** which is based on the internal current/speed curve of the drive;
- **Active Envelope Control (mode 3)** which takes actions based on the evaporating and condensing temperatures/pressures received from the system controller via Modbus.

The 4 modes can be selected from a list through register [231]:
- o 0: Full Envelope Protection
- o 1: High-Speed Envelope Protection
- o 2: Advanced Speed-Drop Protection Mode
- o 3: Active Envelope Protection

4.4.1 Passive Envelope Protection

The passive envelope control implies the so-called Overload Protection. Based on the compressor operation envelope, which is transferred in a speed-current curve, the drive will compute and adjust frequently the output current threshold. Once the output current exceeds this calculated threshold the drive will go in the Speed-Drop Protection (SDP) mode, ie, a kind of power limitation to protect the drive and the stator windings against overload. The difference between the three modes from the user's point of view, consists in the access to different speed ranges and the speed at which the drive folds back in case of speed-drop protection:

<u>0: Full Envelope Protection</u>
- Overload Protection enabled.
- Normal Operation Mode: the minimum speed is the speed available for the whole envelope. Taken from the EEPROM and stored in register [109].
- SDP mode: the speed at which the drive drops is the same as the minimum speed from the Normal Operation mode.
- In this mode the user provides only the speed demand.

1: High-Speed Envelope Protection

- Overload Protection enabled.
- Normal Operation: the minimum speed is the minimum speed of the envelope. Value taken from the EEPROM and updated frequently based on the operating point. The user must take care to run the compressor within the envelope at all times.
- SDP mode: the minimum speed is the speed available for the whole envelope. Taken from the EEPROM and stored in register [109].
- In this mode, besides the speed demand, the user must send the minimum speed for each operating point.

2: Advanced Speed-Drop Protection Mode

- Overload Protection enabled.
- Normal Operation: the minimum speed is the minimum speed of the envelope. The value is stored and updated frequently in register [109].
- SDP mode: the speed at which the drive drops is the minimum speed of the envelope. The value is stored and updated frequently in register [109].
- In this mode, besides the speed demand, the user must also provide the minimum speed depending on the operating point for the Normal Operation and SDP modes in register [109].

4.4.2 Active Envelope Protection

The Active Envelope Control (selectable via register [231], mode 3) comprises of two stages:

Stage I: Out-of-maximum application envelope detection

The drive receives the evaporating and condensing temperatures via Modbus from the system controller. Then it checks whether the operating point is within the envelope. If the operating point is out of the envelope for 15 seconds an alarm is sent to the system controller (bit 12, register [51]).

If the compressor is not running inside the envelope, the drive acts differently based on the region in which the running point is. The outer part of the envelope is spread into two parts: the grey zone below the envelope and the white zone. This particular feature is based on the different behaviour of the installation during start-up. In this way the compressor is allowed to run below the envelope during start-up and defrost, until the setpoint stabilizes within the envelope.
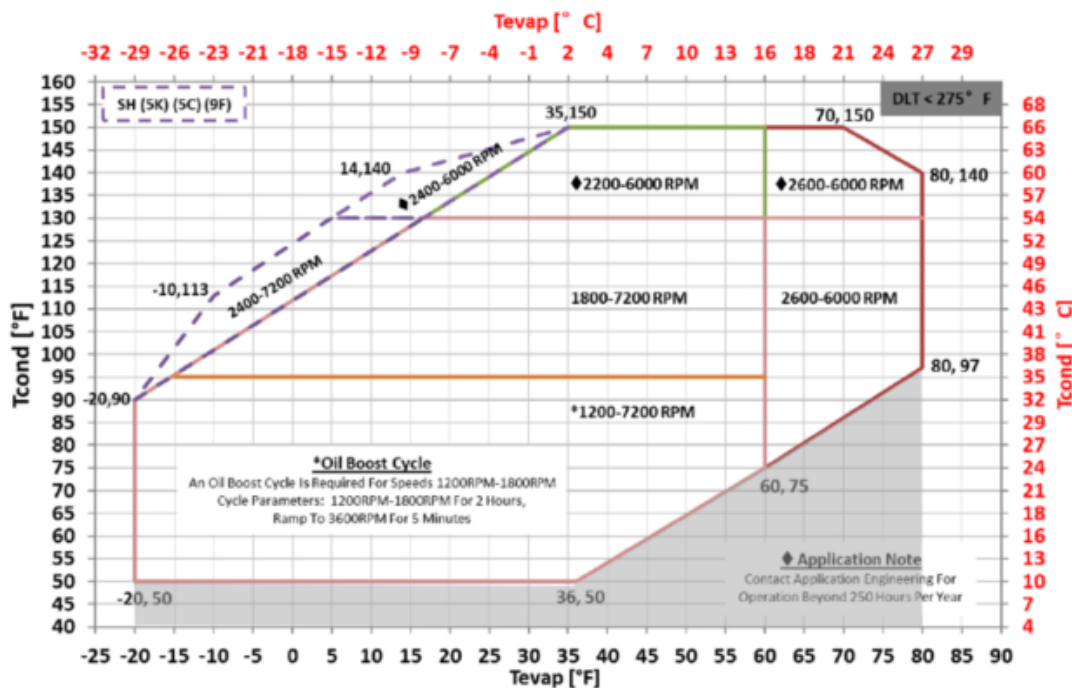

Figure 6: Application envelope of ZPV0962E with R410A (20 °F SH, 15 °F SC, 95 °F ambient)

White zone:

- Speed range: 2600-6000 rpm
- Allowed running time: 30 seconds

Grey zone:

- Speed range: 2600-6000 rpm
- Allowed running time based on the evaporating temperature:
  - if less than -15 °C: 15 minutes
  - if more than -15 °C: 30 minutes

If the speed demand is less than 2600 rpm or more than 6000 rpm, the speed is increased or decreased automatically to respect the speed range. The time and temperature thresholds are readable through registers [318], [319], [320] and [321]. The time remaining for running outside of the envelope is readable through register [47]. The DLT feature is enabled while Active Envelope Protection is in place.

Stage II: Speed limits within an envelope sub-region

If the working point is within the envelope, the drive will limit the speed range of each sub-region of the envelope (minimum speed stored in register [44] and maximum speed stored in register [45]). The coordinates of the point are compared with several predefined lines, for a proper localization of the sub-region.

If the compressor is running outside the allowed speed limits, a warning is given and the speed is changed accordingly.

In case of Speed-Drop Protection, the drive may reduce the speed as low as the minimum allowed speed for the envelope region.

Outside the qualified application envelope, the speed limits are restricted to the whole envelope speed band, ie, 2600-6000 rpm.

There are 6 sub-regions in total, which can be identified in the envelopes as per **Appendix 4**.

4.5 Clearing faults

Faults can be cleared after 30 seconds. To do this, follow the steps below:

1) Set Compressor Speed Demand to zero [101]
2) Set Compressor Enable command to zero [100]
3) Set Clear Fault command [103]

NOTE: **Once a Clear Fault command is sent, faults will only be cleared if their triggering cause is gone. The Clear Fault command remains active until the last remaining fault has been cleared. If all the faults have been cleared, the Clear Fault command will automatically be reset.**

4.6 Compressor start-up

The start-up control is divided into four stages, considering the default values:

- **Stage I:** (~2 seconds) The compressor will run from 0 to 1500 rpm at a default acceleration rate of 600 rpm/s.
- **Stage II:** (T1) The compressor continues to increase its speed from 1500 to 3600 rpm with an acceleration rate of 1000 rpm/s.
- **Stage III:** (T2~120 seconds) The compressor will remain at 3600 rpm for 120 seconds. The speed from region III is set to 3600 rpm by default, but it can be configured through register [213]. Also, the time (default value = 120 seconds) is configurable via register [234].
- **Stage IV:** After 120 seconds, the compressor will reach the commanded speed by a default acceleration/deceleration rate of 200 rpm/s. The acceleration and deceleration rates can be changed by introducing different values into registers [211], [212] (the maximum allowed value is 600 rpm/s).
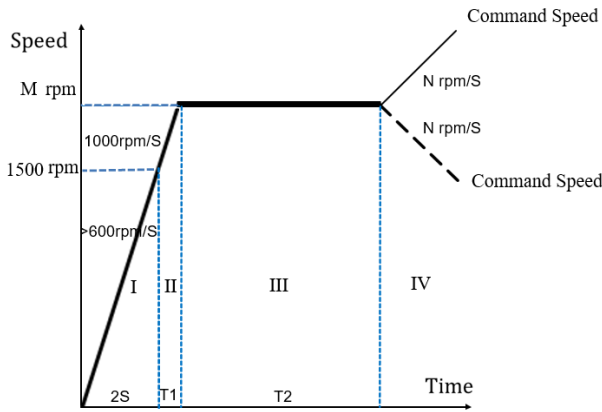
Figure 7: Start-up sequence

4.7 Compressor shutdown

The user has the possibility to perform an immediate shutdown or a controlled shutdown. By setting the compressor Enable register [100] to Disabled, while the speed demand is greater than 0, the drive will perform an immediate stop. Otherwise if the user sends a Disable command as well as 0 speed demand (insert 0 in Compressor Speed Demand register [101]), the drive will issue a controlled stop. During the controlled shutdown, if the speed is lower than 3600 rpm the drive will automatically decelerate towards 0 with more than 1000 rpm/s.

However, if the speed is higher than the platform speed (3600 rpm) it will decelerate with a default rate of 200 rpm/s until it reaches the platform speed, then decelerate automatically with more than 1000 rpm/s. The deceleration rate may be configured through register [210] in the range of 30 to 600 rpm/s.
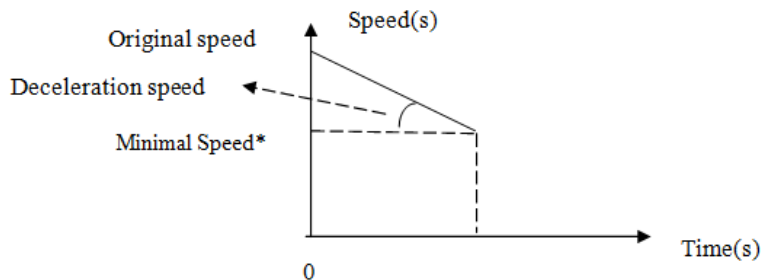
Figure 8: Shutdown sequence

5 Optional analog board

The analog board is foreseen for users who do not have the possibility to control the EV3 drive via an RS485 communication and the Modbus protocol. To control the EV3 drive the analog board needs a digital-enable signal and an analog signal to set the speed or heating demand. The drive compressor package must be selected by a 6-digit DIP-switch. The 7-segment display shows the status, failure codes as well the software version. The board also provides the system controller with a PWM feedback signal with the main information. To protect the compressor a DLT sensor as shown in paragraph 3.4.6 "**Control terminal**" must be wired to the drive control terminal.

If a DLT protection is already part of the system controller a wired resistance of 10 kΩ can bypass this protection on the drive side. In normal operation it is possible to select limited or full speed range via terminal L (CN104). Using the full speed range, the main controller must take care that in each sub-envelope the speed does not go below the allowed speed. Using the limited speed range, the compressor lowest speed is the one which is valid for the whole envelope and is called MMS (Maximum Minimum Speed). In this case running at high load the compressor is well protected against too low and too high speeds. In the Speed-Drop-Protection mode, the drive will only use the limited speed range.
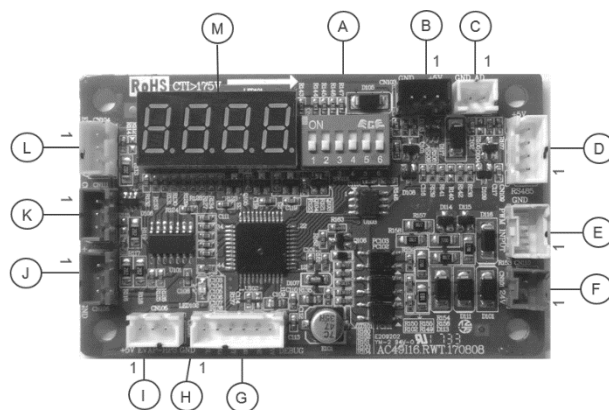
Figure 9: Analog control board

5.1 Terminal and LED description

Table 13 describes in detail the terminals shown in **Figure 9** which are supported by the EV3 drive.

Code	Description and comments
A	**DIP-switch:** Selection of drive compressor package code
B	**PWM-output feedback-signal:** ■ Pin 1: 5 VDC　　　　　>　　　*NA* ■ Pin 2: PWM signal　　>　　*Ext. controller digital input* ■ Pin 3: GND　　　　　>　　*Ext. controller GND* ■ Duty cycle (%): 　0:　　Error (general error, miswiring) 　25:　　Wrong compressor code (power cycle needed) 　50:　　Standby (waiting for enable and 0…10 V signal) 　75:　　SDP mode (Speed-Drop-Protection mode) 　100:　　Running or heating mode
C	**Analog input:** ■ Pin 1: AD (0...10 V)　　>　　*Ext. controller analog output* ■ Pin 2: GND　　　　　>　　*Ext. controller GND*
D	**RS485 communication / power supply:** ■ Pin 1: RS485- (B)　　>　　*EV3 drive control terminal: 5* ■ Pin 2: RS485+ (A)　　>　　*EV3 drive control terminal: 4* ■ Pin 3: GND　　　　　>　　*EV3 drive control terminal: 3* ■ Pin 4: 5 VDC　　　　>　　*EV3 drive control terminal: 2*
E	**PWM input**
F	**Enable signal:** ■ Pin 1: (12 VDC or 24 VDC/AC) ■ 12 VDC / 24 VDC/AC　>　*Ext. controller enable signal* ■ Pin 2: GND　　　　　>　　*Ext. controller GND*

Code	Description and comments
G	**Programming port:** ▪ Used for software updates via Renesas Emulators together with a special PCB board from Emerson
H	**Status LED (green):** ▪ Flashing fast: Fault state ▪ Flashing slow: Standby ▪ Constantly on: Compressor running / heating
I	Not used
J	Not used
K	Used to select the type of feedback on port B: ▪ Without jumper (variable duty cycle (%): 0:.........Tripped 100: ....OK ▪ With jumper (variable duty cycle (%): 0:.........Error (general error, miswiring) 25: ......Wrong compressor code (power cycle needed) 50: ......Standby (waiting for enable and 0…10 V signal) 75:........SDP mode (Speed-Drop-Protection mode) 100:.....Running or heating mode
L	Used for selection of the compressor speed range: ▪ Without bridge between pins 1 and 3 ○ Limited speed range in normal operation (Mode 0: Full Envelope Protection selected – see paragraph 4.4 "**Envelope control**" for more details) ▪ With bridge between pins 1 and 3 ○ Full speed range in normal operation (Mode 1: High Speed Envelope Protection selected – see paragraph 4.4 "**Envelope control**" for more details)
M	**7-segment display:** ▪ Displaying status, speed, error code, software version

Table 13: Terminals and LED's of the analog control board

5.2 Control and configuration

5.2.1 Selection of drive compressor code

The drive compressor code must be selected by a 6-digit binary coded DIP-switch which has to be done before connecting to the drive. In case of a wrong configuration the 7-segment display shows the error code E39. The PWM output shows a duty cycle of 25 %. In this case a power cycle is needed to reset this fault. The DIP-switch will only be analysed once after a power cycle. During the start-up cycle the 7-segment display will show the compressor as per the DIP-switch configuration – see **Table 14**.

	ZPV066-4X9 YPV066-4X9	ZPV096-4X9 YPV096-4X9
Package code	44	45
Binary code	001101	101101
Nixie tube	C044	C045

Table 14: Package codes for ZPV*/YPV* compressors

The binary code reflects the DIP-switch positions from left to right (from 1 to 6), "1" meaning ON state for the switch, "0" meaning OFF state for the switch.

Example:
- Drive version: EV3185B-K1-294
- Compressor version: ZPV096-4X9
- Package code: 45
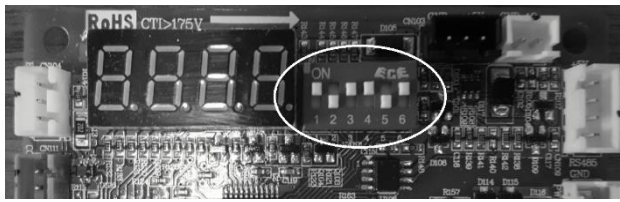- Binary code: 101101

Figure 10: Analog control board code selection

NOTE: **The binary code represents the binary transformation of the package code starting from right to left (from 6 to 1).**

5.2.2 Clearing faults

Faults are cleared automatically as long as the cause of the fault is no longer existing. In case of a drive fault the analog board will automatically send the clear fault command to the drive. Once the fault on the drive is gone the fault gets reset: after a delay time of approximately 30 seconds the drive will return to normal operation mode.

5.2.3 Control signals

To control the compressor the analog board needs an enable signal between 12 and 24 VDC at terminal F.

To control the speed and the stator heating demand a 0…10 VDC signal is required at terminal C.

A PWM feedback signal is available at terminal B.

5.2.4 Stator heating control

To control the stator heating of the compressor, the analog control board considers the range between 1 and 1.9 V – see **Table 15**. The actual heating power depends on the type of compressor.

Voltage (V)	Heating power (%)
≥ 1.0	10
≥ 1.1	20
≥ 1.2	30
≥ 1.3	40
≥ 1.4	50
≥ 1.5	60
≥ 1.6	70
≥ 1.7	80
≥ 1.8	90
≥ 1.9	100

Table 15: Analog stator heating control mode

5.2.5 Speed control

To control the compressor speed, the analog control board considers the range between 2 and 9 V of the analog input signal as the setpoint – see **Table 16**.

Voltage (V)	Speed (Hz)	Speed (rpm)
2.0	15	900
3.0	30	1800
4.0	45	2700
5.0	60	3600
6.0	75	4500
7.0	90	5400
8.0	105	6300
9.0	120	7200
10.0	120	7200
Speed (Hz) = (Voltage-2) * 15 + 15; (2 ≤ Voltage ≤ 9)		

Table 16: Analog speed control mode

Based on the compressor envelope and the speed range selection (see paragraph 5.2.7 "**Compressor speed range selection**") it can happen that low speed demands will be ignored.

5.2.6 Shutdown conditions

The drive will stop in heating as well as in running mode if one of below conditions occurs:

- system or drive fault is detected;
- enable signal is gone;
- analog signal gets lower than 0.5 V.

5.2.7 Compressor speed range selection

With a bridge on terminal L (CN104) the full application envelope speed range is usable in normal operation. In this case the main controller must have a proper envelope control implemented. Without this bridge, the drive will limit the lowest speed to MMS.
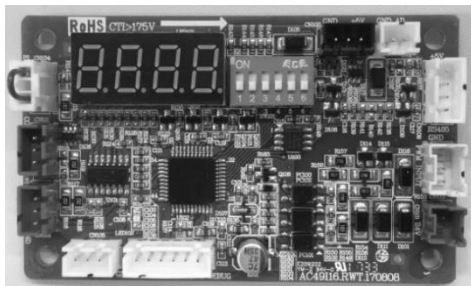
Figure 11: Analog board speed range selection

In speed-drop-protection mode the drive will only use the limited speed range. In this case the speed will not go below the MMS speed.

5.2.8 Onboard 7-segment display

The onboard 7-segment display shows the main information about the drive compressor status, failure and warning codes which are part of **Table 19**.

Board state	Description
Power on (5 seconds)	Alternating between selected drive compressor code (ie, C023) and software version (ie, S04.8)
Standby	Alternating between IDLE and software version
Stator heating	Shows the selected power in % between 0 and 100 % (H-00, H100)
Speed control	The display shows the compressor speed in rpm
Speed-drop protection	Alternating between the compressor speed and the root cause (ie, Sd06) shown in **Table 19**.
Fault state	Displaying the fault code described in **Table 19**.

Table 17: Analog board status display

6 Protections and alerts

When the drive is in normal operation, the power LED will always be turned on and the fault LED will be off. In case the drive is in fault or protection mode, the fault LED will flash at 2 Hz for a specific number of times. The frequency of the LED flashing is linked to one of the alarm codes shown in **Table 20**.

6.1 Speed-Drop Protection mode

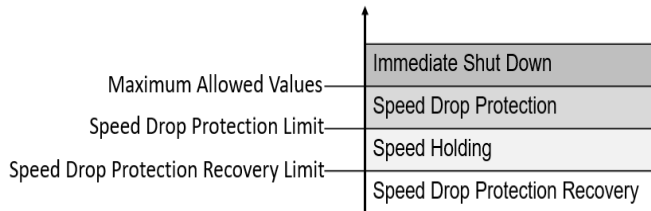To protect the drive in case of overcurrent or overtemperature, the drive will take over the speed control to reduce the component stress by decreasing the speed.

Four different speed-drop protection levels can be used and are shown below:

Figure 12: Speed-Drop Protection logic

- Immediate shutdown
  - o The compressor will be shut down
- Speed-Drop Protection
  - o The compressor speed will drop by 200 rpm/s
- Speed Holding
  - o The compressor speed will be kept constant
- Speed-Drop Protection Recovery Limit
  - o Undercut this limit the drive will recover and will give back the speed control to the controller.

Going upwards the speed-drop protection axis:

If the current/temperature value exceeds the speed drop protection limit, the drive will take over the speed control.

If Active Envelope Control is used, the drive can foldback the speed of the compressor to the minimum speed of the sub-region in which it operates (stored and frequently updated depending on the region, in registers [44] and [109]).

If running in Full Envelope Control mode, the foldback speed will be the minimum allowed compressor speed valid for the whole envelope (stored in register [109]). An immediate shutdown will occur if the Maximum Allowed Values limit is exceeded.

Going downwards the speed-drop protection axis:

If the current/temperature value during the Speed-Drop Protection mode reaches the foldback speed it will stay at that level. In case of additional speed reduction need, the drive will stop the compressor after 30 seconds and a timeout fault will be triggered in registers [79] and [81].

If the current/temperature value decreases into the speed holding area, the compressor speed will be kept constant, at the value at which it was running when the speed-drop protection limit was crossed.

If the current/temperature value is between the speed holding limit and recovery limit the following control method is used:

- The compressor will run at reduced speed.
- The controller partially gets back the control (only allowed to decrease the speed in this area).
- If possible the controller should adjust the system parameters to come below the recovery limit!
- Once the recovery limit is undercut or the compressor runs at this stage for longer than 30 seconds, the system controller will get back the full speed control.

NOTE: **The drive will inform the controller by updating Modbus registers [5] and [51].**

Reasons for moving to Speed-Drop Protection mode:

- Overtemperature of the power module
- Overtemperature in the discharge line
- Operating in field weakening range
- Output overcurrent
- Input overcurrent
- Drive ambient temperature foldback

The controller can avoid moving to the Speed-Drop Protection mode by using registers [37], [39], [40], [41], [42] and [46] for control purposes.

6.2 Power module speed-drop protection

Considering the described speed-drop protection behaviour, the logic for the power module protection follows the diagram below:
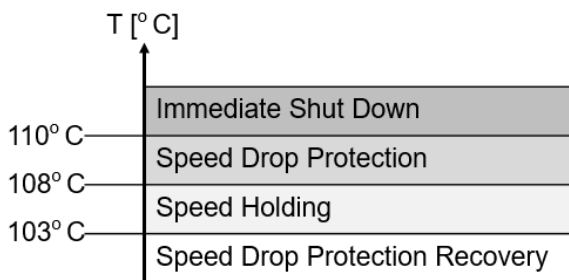
Figure 13: Power module speed drop protection logic

If the temperature reaches 108 °C, the drive will take over the speed demand and will reduce it to the speed-drop protection speed, in an attempt to reduce the module temperature.

If the speed reaches its speed-drop protection value, and the temperature is still above 108 °C for 30 seconds, the drive will automatically shut down the compressor.

However, if the temperature decreases below 108 °C, the drive will enter in the Speed Holding area, where the speed is kept constant, until the temperature goes below the recovery value, ie, below 103 °C.

If the temperature goes below the recovery value, the drive will return to the speed commanded initially.

6.3 Discharge line temperature protection

If a discharge line temperature sensor is wired and activated via register [207] the drive will control this temperature. This is achieved via the DLT value [77] considering a lower speed-drop protection limit readable via register [46] or configurable via register [110] and an upper maximum limit [27]. For YPV* compressors the DLT trip limit ([27]) is configurable through register [222]. The register can be set within the range of 135 to 150 °C. The configured value will be written in register [27].

Once the drive goes into speed-drop protection mode the functionality is the same as described in Chapter 6.1 "**Speed-Drop Protection mode**".

Limits	Register	Default values
Trip limit	[27]	135 °C
SDP limit	[46]	130 °C
SDP recovery threshold	-	125 °C

Table 18: DLT speed-drop protection temperatures

NOTE: **The discharge line temperature speed-drop protection can be disabled through register [232]. In this case the drive will shut down the compressor immediately when exceeding the upper limit.**

6.4 Speed drop protection limits, LED and analog board codes

In case of failure, the alarm code is visible at the signal LED. The number of blinks is equal to the alarm code.

No	Alert and fault message	Static, dynamic and recovery limits	Protective action	Analog board	Alarm code	#OneEmerson Register bit
1	Drive power under voltage	N/A	Compressor trip	-	5	-
2	DC overvoltage	**Limit / recovery** 800 V / 720 V	Compressor trip	E03	6	80.2
3	DC undervoltage	**Limit / recovery** 300 V / 380 V	Compressor trip	E04	7	80.3
4	AC input undervoltage	**Limit / recovery** 295 V / 325 V	Compressor trip	E06	11	80.5
5	Drive module overtemperature	**Limit / recovery** EV3150B: 110 °C / 85 °C EV3185B: 110 °C / 85 °C	Compressor trip	E12	12	80.11
6	Compressor DLT overtemperature	**Limit / recovery** 135 °C / 115 °C	Compressor trip	E25	13	81.8
7	Communication fault	30 seconds	Compressor trip	E24	14	81.7
8	EEPROM fault	EEPROM CRC incorrect	Compressor trip	E37	15	84.4
9	Wrong compressor code	N/A	Compressor trip	E39	16	84.6
10	Output U phase current sampling fault	N/A	Compressor trip	E44	17	84.11
11	Output V phase current sampling fault	N/A	Compressor trip	E10	18	80.10
12	Output W phase current sampling fault	N/A	Compressor trip	E10	19	80.10
13	Input current sampling fault	Input current AD < 1658 or input current AD > 2487	Compressor trip	-	20	-
14	Drive module temperature sampling fault	If the module temperature read from the ADC is: ADC_temp < 38 or ADC_temp > 2900	Compressor trip	E54	21	85.5
15	DLT temperature sampling fault	If the DLT temperature read from the ADC is: ADC_temp < 64 or ADC_temp > 2650	Compressor trip	E51	22	85.2
16	Compressor loss of motor control	If compressor estimated speed is below 0, or compressor voltage is below 15 V for 1 second	Compressor trip	E11	23	80.10
17	Compressor overspeed	N/A	Compressor trip	-	24	-
18	Envelope timeout	-	-	-	27	-
19	Module temperature foldback timeout	**Speed-drop protection limit / recovery value** EV3150B, EV3185B: 108 °C / 103 °C	Compressor speed drop	E20	28	81.3
20	Input current foldback timeout	**Speed-drop protection limit / recovery value** EV3150B: 30 A / 28 A EV3185B: 41 A / 39 A	Compressor speed drop	-	29	81.4

No	Alert and fault message	Static, dynamic and recovery limits	Protective action	Analog board	Alarm code	#OneEmerson Register bit
21	Compressor low voltage	N/A	-	-	30	-
22	Cooling fan fault	This fault will be triggered if the fan stops working	Compressor trip	E64	31	85.15
23	Drive module HW overcurrent	Dependent on the system	Compressor/ PFC trip	E44	49	84.11
24	Compressor U phase SW overcurrent	Read from EEPROM	Compressor trip	E41	50	84.8
25	Compressor V phase SW overcurrent	Read from EEPROM	Compressor trip	E42	51	84.9
26	Compressor W phase SW overcurrent	Read from EEPROM	Compressor trip	E43	52	84.10
27	Compressor overload	EV3150B: 28 A RMS EV3185B: 39 A RMS	Compressor trip	E48	53	84.15
28	Compressor loss U phase	-	-	-	54	-
29	Compressor loss V phase	-	-	-	55	-
30	Compressor loss W phase	-	-	-	56	-
31	Compressor start-up fault	The compressor fails starting 3 times	Compressor trip	E14	57	80.13
32	High pressure protection	N/A	Compressor trip	E09	58	80.8
33	Compressor motor phase current imbalance	The difference between the maximum and minimum compressor phase currents RMS value exceeds 4 A	Compressor trip	E07	59	80.6
34	AC input loss of phase	The maximum value of input voltage (RMS) exceeds 1.5 x the minimum value of input voltage	Compressor trip	E10	60	80.9
35	AC input overcurrent	EV3150B: 31 A RMS EV3185B: 42 A RMS	Compressor trip	E02	63	80.1
36	AC input undercurrent	Input current below 1 A and output current above 20 A	Compressor trip	-	64	-
37	Compressor U phase current no change	-	-	-	65	-
38	Compressor V phase current no change	-	-	-	66	-
39	Compressor W phase current no change	-	-	-	67	-
40	ADC fault	ADC base AD > 2662 or ADC base AD < 1433	Compressor trip	E56	68	85.7

Table 19: Protection limits, LED and analog board codes

7.1   General statements
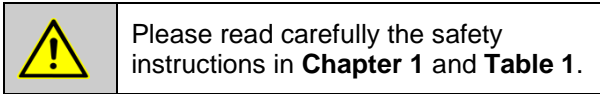
> ⚠ Please read carefully the safety
> instructions in **Chapter 1** and **Table 1**.

- Correct handling and storage of the drive is essential in preventing mechanical damage.
- The box and the protection bag inside the box have to be opened with care. Do not use any sharp object to open the protection bag or cut across the drive.
- Once opened do not stack the drives.
- Do not use chemicals or solvents to clean the drive.
- Do not drop any mechanical tools on the drive.
- Check frequently that the cooling slots, fans and heatsink are free of dust to ensure efficient cooling.

7.2   Fan replacement

In case the fan breaks, it can be easily replaced. Use the following installation procedure for replacement:

1) Identify the fan position on the drive (below the input and output terminals of the drive).
2) Press on the clips on the left and right sides of the plastic housing and take the fan out. The housing being attached to the fan, both will come out at the same time.
3) Once taken out, extract the fan from the plastic inlet.
4) The fan is connected with a lock-type connector to the main board of the drive.
5) Press the plastic clip of the connector and disconnect the fan.
6) Connect the new fan and reassemble the unit.

The replacement fan model is supplied by Emerson under ident number 8421949.

8 Frequently asked questions

Table 20 provides answers to frequently asked questions. Please check here first in case of problems with the installation and assembly. In case further assistance is needed please contact the Application Engineering department at Emerson.

No	Alert & fault message	Static, dynamic & recovery limits	Protective action	Analog board	Alarm code	#OneEmerson Register bit	Check & corrective action
1	DC overvoltage	**Limit / recovery** 800 V / 720 V	Compressor trip	E03	6	80.2	The drive is not running under stable conditions; check the DC bus voltage for abnormal oscillations. Restart the drive and try running the unit again. If the problem persists, replace the drive.
2	DC undervoltage	**Limit / recovery** 300 V / 380 V	Compressor trip	E04	7	80.3	
3	AC input overvoltage	**Limit / recovery** 520 V / 510 V	Compressor trip	E05	10	80.4	Check the voltage rating of the mains and the input connection to the drive. The drive is designed to work for 380-460 VAC.
4	AC input undervoltage	**Limit / recovery** 295 V / 325 V	Compressor trip	E06	11	80.5	
5	Drive module overtemperature	**Limit / recovery** EV3150B: 110 °C / 85 °C EV3185B: 110 °C / 85 °C	Compressor trip	E12	12	80.11	Check if the fan is on and working properly. If the fan is broken, the module will overheat, and the drive will report this error. If the fan is damaged, replace it as per instructions given in chapter 7.2.
6	DLT high temperature	**Limit / recovery** 135 °C / 115 °C	Compressor trip	E25	13	81.8	In case the DLT sensor temperature exceeds 135 °C, the drive will report this error.
7	Communication fault	30 seconds	Compressor trip	E24	14	81.7	If there is no communication between the drive and the controller for 30 seconds, this error will be reported. Check the connection on the communication port and make sure the communication parameters are in accordance with table 4 in chapter 2.4 "Advanced technical information". Check if the counterpart of the green terminal is properly fitted.
8	EEPROM fault	EEPROM CRC incorrect	Compressor trip	E37	15	84.4	Check the EEPROM file that was flashed on the drive. For each drive model, there is a specific EEPROM file. If a different file is flashed, this error will be reported. This fault is only clearable with a power cycle.
9	Wrong compressor code	N/A	Compressor trip	E39	16	84.6	For the EV3 drive, there is no need to change the compressor code! The EEPROM file contains the compressor model; if the drive is properly flashed, there is no need to adjust this parameter. The correct compressor codes are: ZPV/YPV066 => 700 ZPV/YPV096 => 800
10	Inverter desaturation	N/A	Compressor trip	E08	-	80.7	Restart the drive. If the fault persists, replace the drive.
11	Power module temperature sensor open / short fault	If the module temperature read from the ADC is: ADC_temp < 38 or ADC_temp > 2900	Compressor trip	E54	21	85.5	The power module temperature sensor is damaged. The drive must be replaced.
12	DLT temp sensor open / short fault	If the DLT temperature read from the ADC is: ADC_temp < 64 or ADC_temp > 2650	Compressor trip	E51	22	85.2	Check if the DLT sensor is enabled in register [207]. If so, check if the DLT sensor is properly connected to the communication port. If the sensor is enabled and there is no sensor connected (or there is a short between the DLT terminals), this fault will be reported. If above instructions do not solve the problem, try measuring the resistance value of the DLT sensor to check if it works properly. Once everything is properly connected, a power cycle is required on the drive in order to eliminate the fault.
13	Compressor loss of motor control	If compressor estimated speed is below 0, or compressor voltage is below 15 V for 1 second	Compressor trip	E11	23	80.10	Restart the drive and try running the compressor again. Check the connection to the compressor, and make sure all three phases are properly connected. If the problem persists, check the compressor: the rotor might be demagnetized.

| No	Alert & fault message	Static, dynamic & recovery limits	Protective action	Analog board	Alarm code	#OneEmerson Register bit	Check & corrective action
14	Compressor phase current foldback timeout	If compressor is running outside the envelope for 30 seconds. In Active Envelope protection mode the compressor is allowed to run outside for a longer time.	Compressor trip	E19	27	81.2	Check if the compressor is running within the envelope. Check the envelopes in Appendix 4 and read chapter 4.4 for further information on Envelope Control.
15	Module temperature foldback timeout	**Speed-drop protection limit / recovery value** EV3150B, EV3185B: 108 °C / 103 °C	Compressor speed drop	E20	28	81.3	Check if the fan is on and working properly. If the fan is broken, the module will overheat, and the drive will report this fault.
16	Input current foldback timeout	**Speed-drop protection limit / recovery value** EV3150B: 30 A / 28 A EV3185B: 41 A / 39 A	Compressor speed drop	E21	29	81.4	Check the compressor load. This fault will be triggered if the load is too high for a certain speed during 30 seconds.
17	Cooling fan fault	-	Compressor trip	E64	31	85.15	This fault will be triggered if the fan stops working. If the fan has been replaced, check the connections as per instructions in chapter 7.2. If the fan still does not work, replace the drive.
18	Drive module HW overcurrent	Dependent on the system	Compressor trip	E44	49	84.11	This fault appears when there is a short between phases or in case of a locked rotor event. Check if the connections between drive and compressor are properly made and restart the drive. If the fault persists, replace the drive, as the power module might be damaged.
19	Compressor U phase overcurrent / sensor fault	Read from EEPROM	Compressor trip	E41	50	84.8	If this fault appears, it can only be cleared with a power cycle on the drive. Check the wiring to the compressor and run the motor again. If the fault persists, replace the drive.
20	Compressor V phase overcurrent / sensor fault	Read from EEPROM	Compressor trip	E42	51	84.9	
21	Compressor W phase overcurrent / sensor fault	Read from EEPROM	Compressor trip	E43	52	84.10	
22	Compressor overload	EV3150B: 28 A RMS EV3185B: 39 A RMS	Compressor trip	E48	53	84.15	Send a clear fault command then restart the compressor. Adjust the load so that the output current does not exceed 38 A for 18.5 kW and 27 A for 15 kW.
23	Compressor start-up fault	-	Compressor trip	E14	57	80.13	This fault is triggered when the compressor fails to start 3 times. Check if the wires are correctly connected to the compressor. If it still fails, try interchanging two wires and restart the compressor.
24	High pressure protection	N/A	Compressor trip	E09	58	80.8	This fault will appear at start-up if the HPS is not connected. If it is not used, a short must be made on the HPS terminals. The fault can only be cleared with a power cycle.
25	Compressor motor phase current imbalance	-	Compressor trip	E07	59	82.0	The difference between the maximum and minimum compressor phase currents RMS value exceeds 4 A. Check the compressor U,V,W connections first, and make sure that the screws are tight. If the problem persists, check the values of the compressor currents with the scope. If a difference in currents can be observed on the scope, replace the drive first. If the fault persists, the compressor must be replaced.
26	AC input loss of phase	The maximum value of input voltage (RMS) exceeds 1.5 x the minimum value of input voltage	Compressor trip	E10	60	80.9	Check the connection to the grid. This fault will be triggered when a phase is not properly connected.
27	AC input overcurrent	EV3150B: 31 A RMS EV3185B: 42 A RMS	Compressor trip	E02	63	80.1	The compressor load is too high. Try reducing it and check if the fault still appears.
28	ADC fault	ADC base AD > 2662 or ADC base AD < 1433	Compressor trip	E56	68	85.7	Restart the drive. If the fault persists, replace the drive.
29	Microelectronic fault	-	Compressor trip	E35	-	84.2	
30	Compressor loss of phase	-	Compressor trip	E10	-	80.2	Check that all motor U,V,W phases are properly connected and that there is no loose cable. This fault is triggered when one of the motor cables is not connected.

No	Alert & fault message	Static, dynamic & recovery limits	Protective action	Analog board	Alarm code	#OneEmerson Register bit	Check & corrective action
31	DLT temperature timeout	30 seconds	Compressor speed drop	E22	-	81.5	This fault will be triggered if the DLT temperature exceeds 130 °C for more than 30 seconds. Restart the drive and run at a lighter load to avoid this fault.
32	Auto configuration communication timeout	-	Compressor trip	E23	-	81.6	The drive automatically recognizes the baud rate, without the need to configure it. Check if the master sends messages at baud rates that are accepted by the drive.
33	Board temperature sensor open / short	-	Compressor trip	E27	-	85.12	This fault is triggered by the ambient sensor, which is placed on the top of the drive main board. Make sure that the temperature inside the drive case does not exceed 75 °C. Restart the drive. If this fault appears again, replace the drive.
34	Stator heater overcurrent	-	Compressor trip	-	-	85.13	This fault will be triggered during stator heating if the current is too high. Under normal conditions, the drive should automatically limit the power to 150 W during stator heating. As a first step measure the power delivered by the drive to the compressor. If the power is too high, measure the windings of the compressor. If the compressor works properly but the fault persists, replace the drive.
35	Fault lockout	10 failures in 10 hours	Compressor trip	E64	-	85.15	When the EV3 drive is commanded by one of the Emerson controllers, this functionality is disabled. When the EV3 drive is running in a unit without Emerson controller this functionality is enabled by default. If the functionality is enabled, the drive automatically locks out after 10 failures (Compressor phase Over Current, Micro Electronic Fault, Start-up fault, Compressor U,V,W sensor fault) within 10 hours, and cannot be commanded anymore. The drive will remain in lockout state for 10 hours. It will exit the lockout state and be operational again if a power cycle is made.

Table 20: Frequently asked questions (FAQ's)
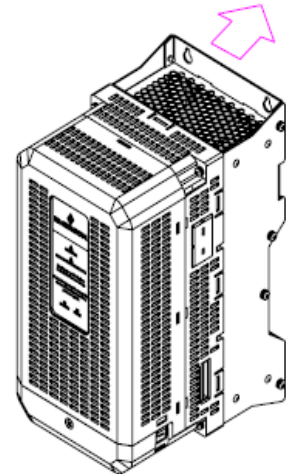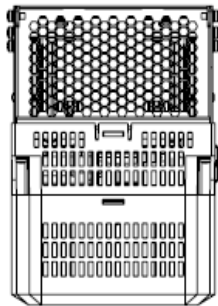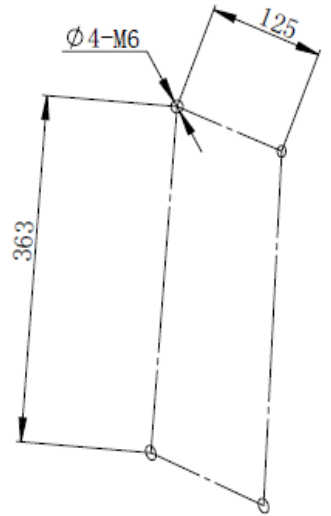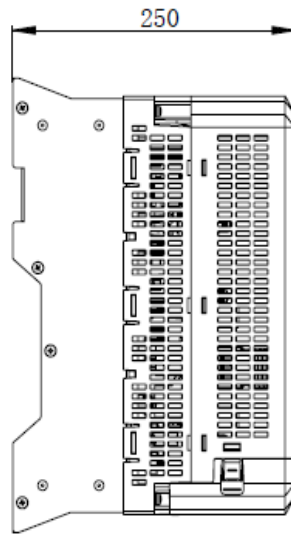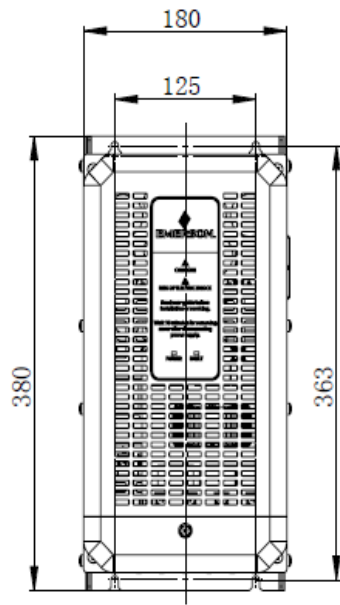
Appendix 2: Choke dimensions
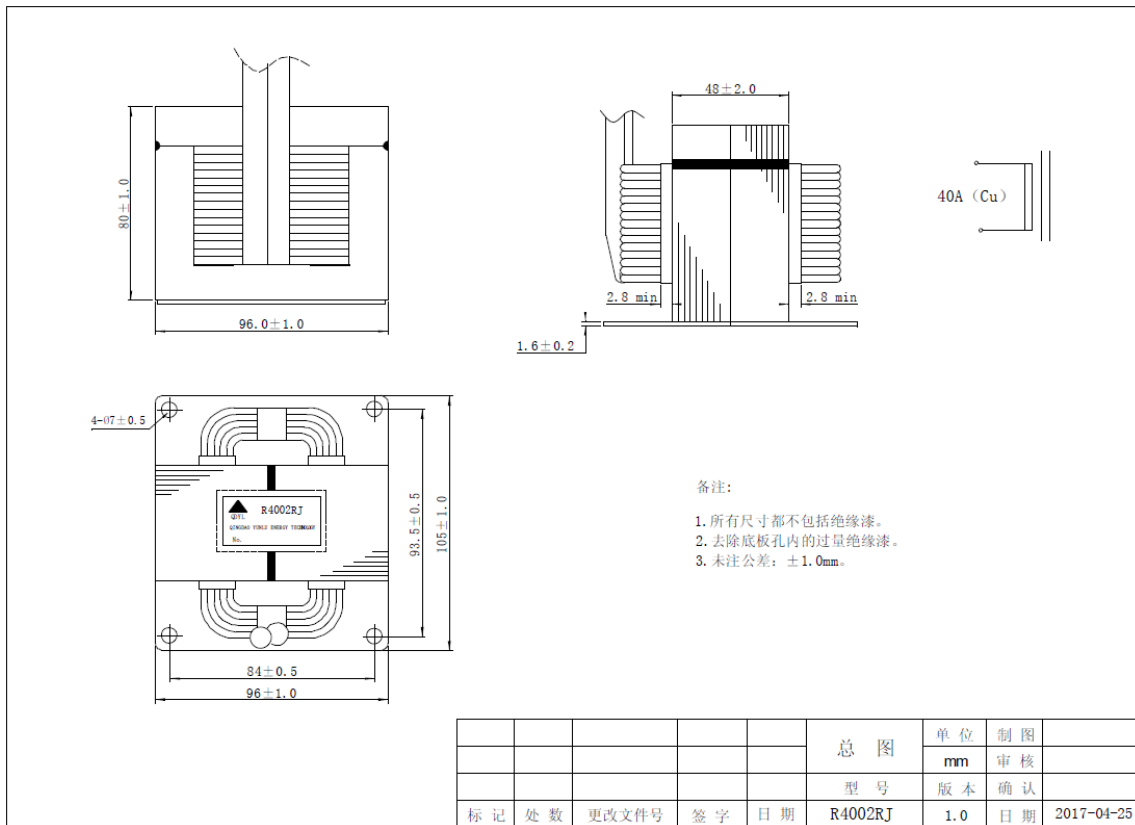
Figure 14: DC choke 40A, 2mH for EV3150B
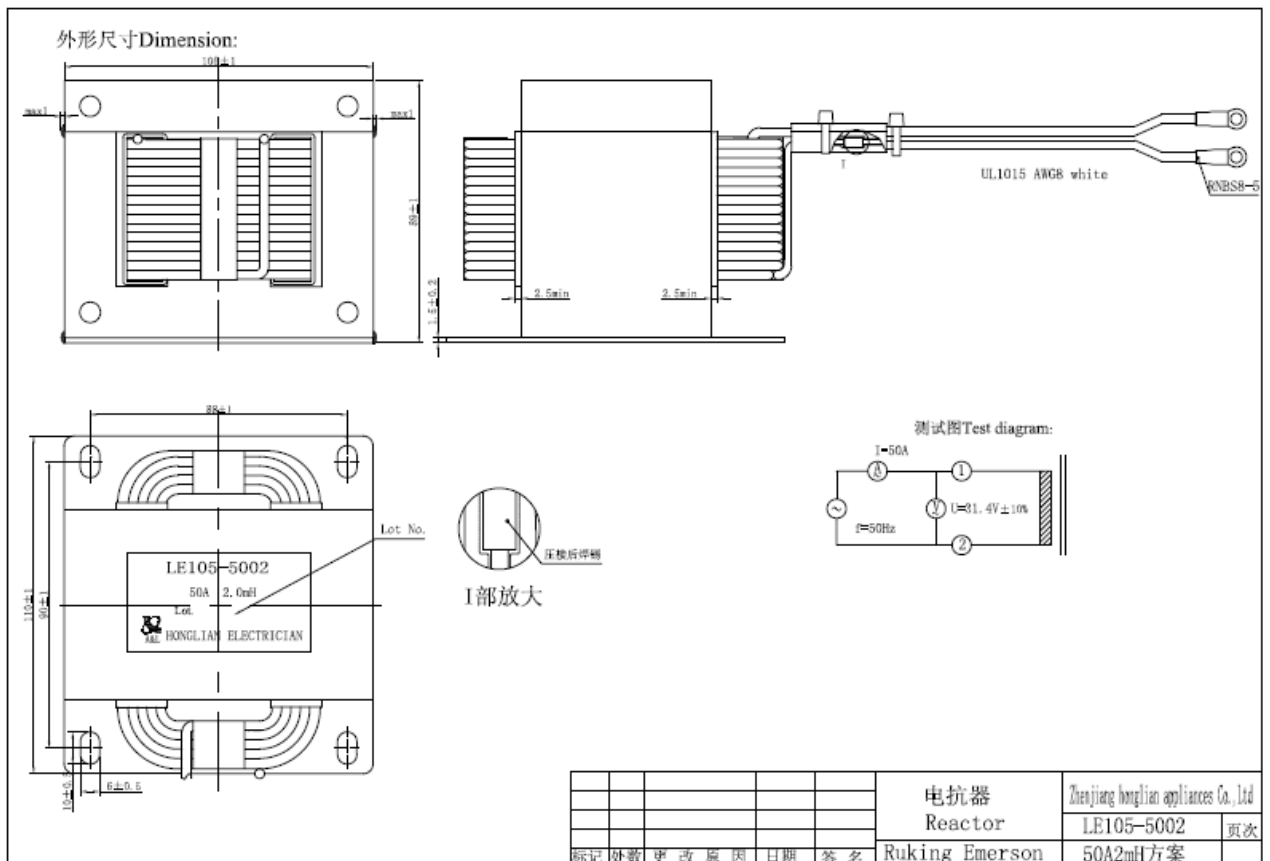
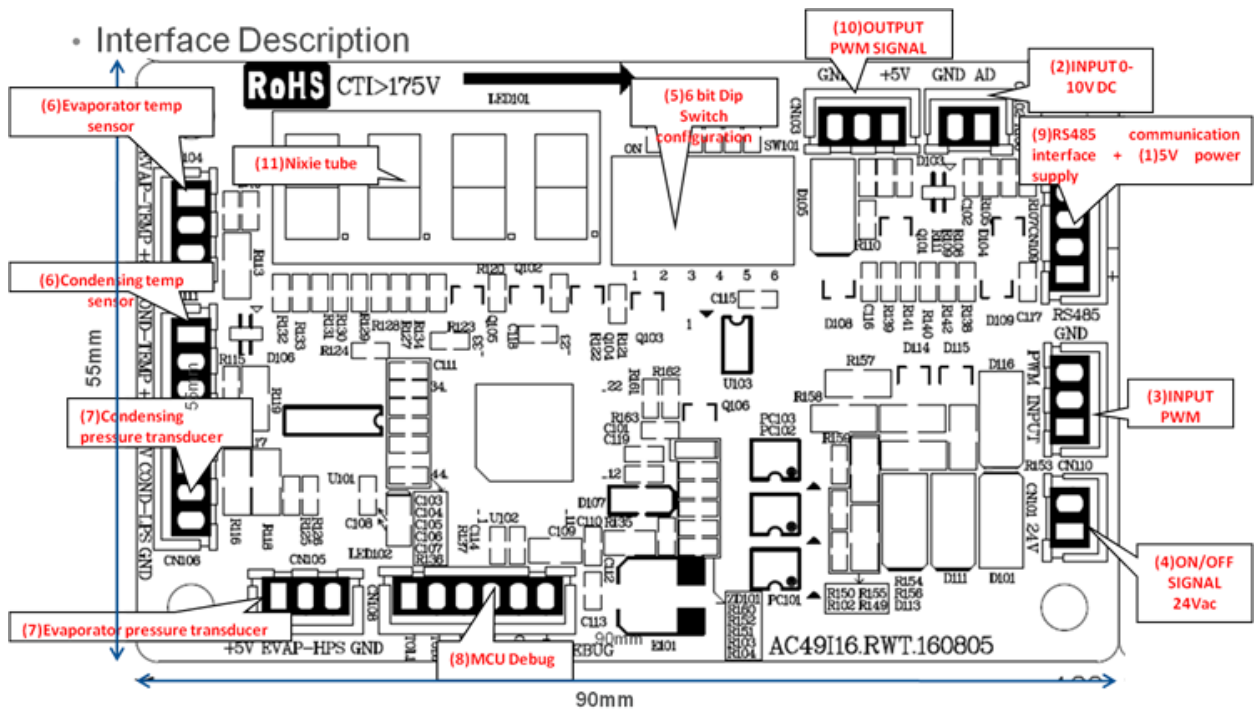**Figure 15: DC choke 50A, 2mH for EV3185B**

Figure 16

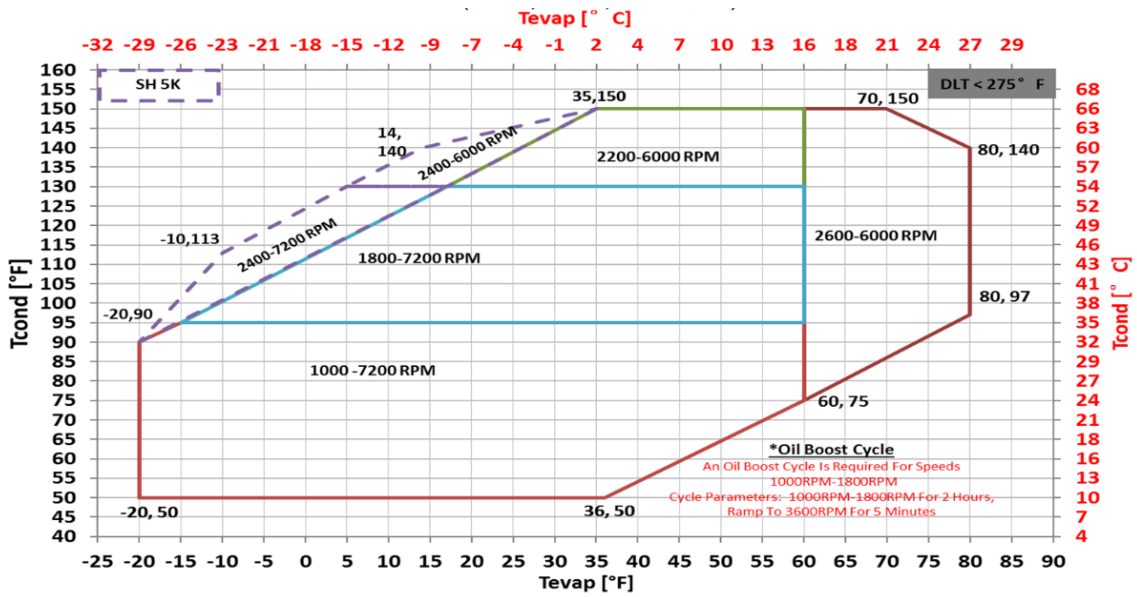## Appendix 4: Envelopes

Figure 17: ZPV066* compressor envelope with R410A (20 °F SH, 15 °F SC, 95 °F ambient)
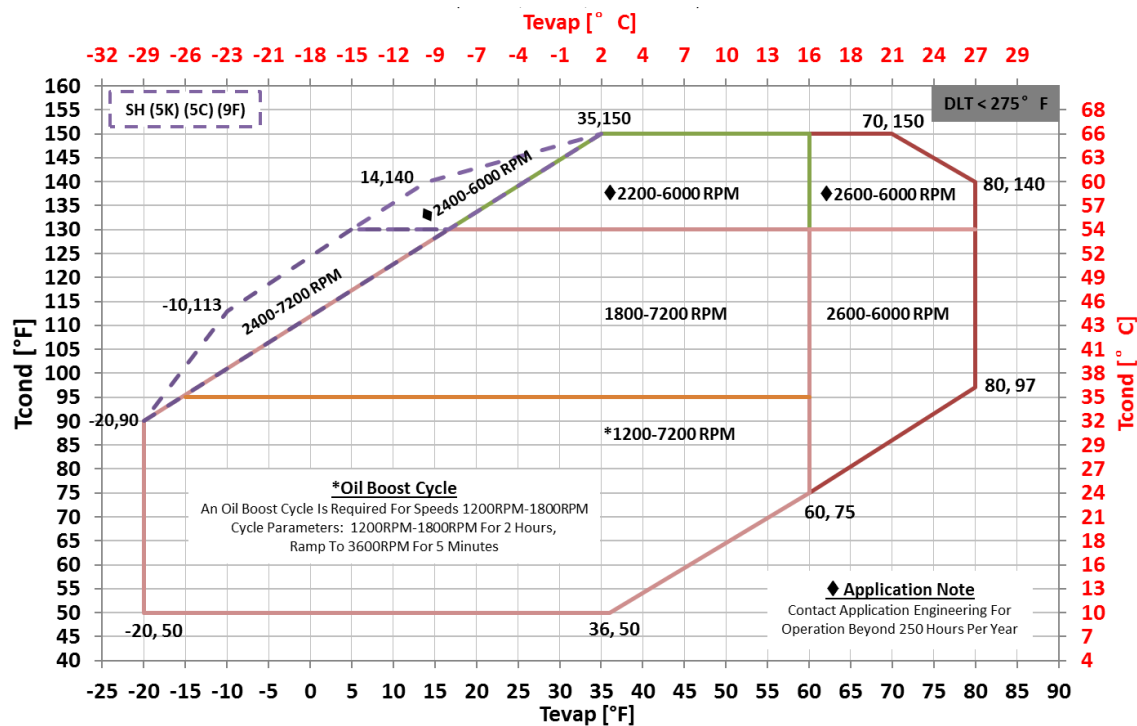

Figure 18: ZPV096* compressor envelope with R410A (20 °F SH, 15 °F SC, 95 °F ambient)

Appendix 5: Advanced user interface

An advanced user interface is available to control the drive without any other kind of controller. Its main functions are as follows:

- Drive control
- Drive configuration
- Changing default parameters like the Modbus address (default set to 45)
- Real-time Modbus data analysis
- Updating drive software (DSP & EEPROM)
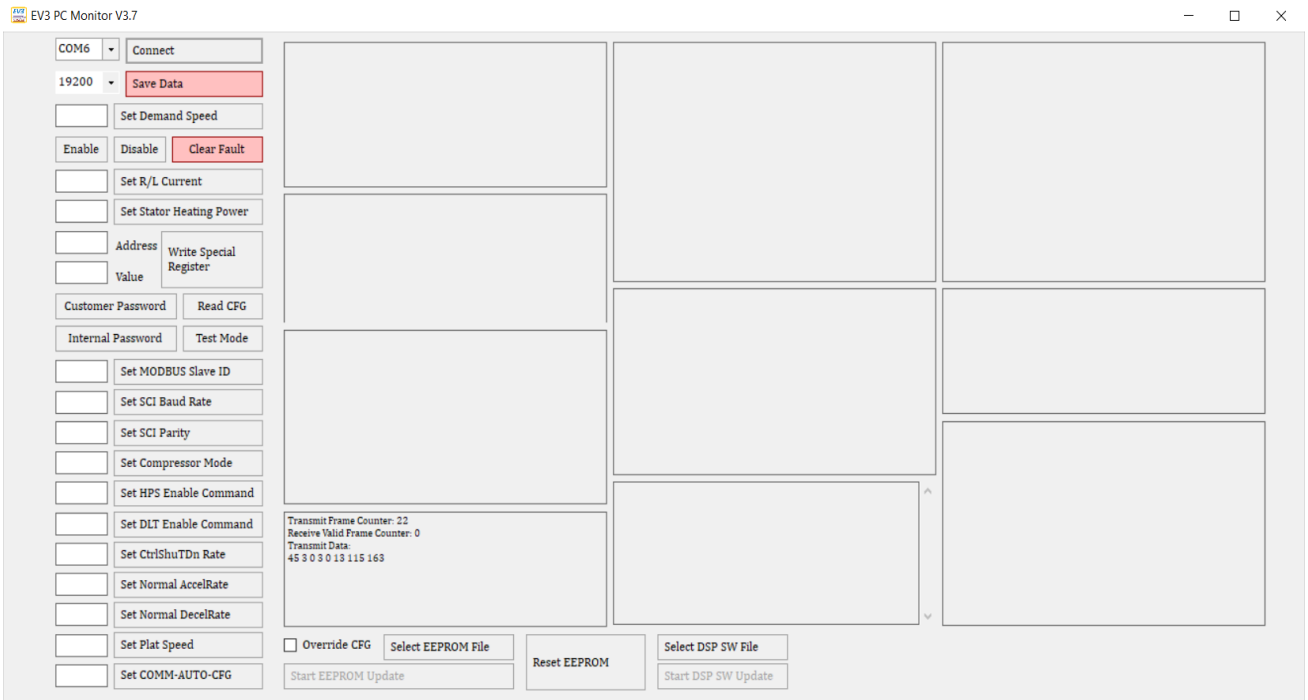
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